

# Leaf scald of sugarcane

**Leaf scald, a bacterial disease of sugarcane, is currently spreading rapidly worldwide. It can only be controlled preventively with techniques to propagate and distribute certified healthy plants, along with strict varietal selection.**

**L**eam scald of sugarcane (interspecific hybrids of *Saccharum* sp.) is a bacterial vascular disease caused by *Xanthomonas albilineans* (Ashby) Dowson. It can have a serious economic impact when susceptible varieties are affected in sugarcane crop zones (RICAUD & RYAN, 1989). This direct effect is most obvious when the first outbreaks occur in a country, or when a new strain of the pathogen appears in an already contaminated area.

## Symptoms

The symptomatology includes two main forms, chronic and acute, and two distinctive phases, latency and eclipse (ROTT *et al.*, 1988; RICAUD & RYAN, 1989).

### Chronic form

The chronic form is characterized by lines on the leaf blades, running parallel to the ribs. These lines, or streaks, resemble straight pencil lines, but can be as wide as 1 cm. They gradually spread along the leaf blade and vary in colour from white to yellow on the blade. They become purplish when reaching the leaf sheath (AUTREY *et al.*, 1992b), and can turn reddish with age. This is the only visible external symptom in resistant varieties.

With progress of the disease, the streaks broaden and become more diffuse on leaves that are reaching maturity. The leaf tissues whiten. Chlorosis of all of the leaves can

occur and they will turn a whitish colour. In addition to the loss of colour, the leaf tips can wither and curl inward, giving a spindly appearance to the shoots.

On mature chronically infected stalks there is almost simultaneous development of side shoots with no apical dominance. Shoots at the base of the stalk may thus be more developed. This differs from situations when apical dominance is interrupted on a healthy stalk by clipping off the apex, when only the youngest shoot located below the apical meristem will develop. The side shoots that form exhibit the same symptoms as the main stalks.

In longitudinal sections, infected stalks are characterized by reddened vessels in the nodal and internodal areas.

### Acute form

The acute form is characterized by sudden wilting of mature stalks. When there is no chronic symptom expression, apparently disease-free stalks can begin withering, looking like they lack water.

The onset of this form is often subsequent to a rainy period followed by prolonged dry weather, but seems to be limited to highly susceptible varieties.

### Latency and eclipse phases

During the long latency period of the disease, many infected plants exhibit no symptoms or sometimes just a few white lines on their leaves. It is not

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## Variability in the causal organism

Recent studies have focused on variations in *X. albilineans* (ROTT & DAVIS, 1994). This is a critical factor for the development of diagnostic and detection techniques, and determining the most virulent strains, when screening for leaf scald disease resistant varieties of sugarcane.

Development or introduction of new pathogen strains has often been blamed for loss of varietal resistance to leaf scald. However, this has never been categorically proven. There are pathogenicity variations in *X. albilineans*, and AUTREY *et al.* (1992a) recently published evidence on the presence of different races of this bacterium in Mauritius.

### Types of variation

Several types of variation concerning different traits have been identified, e.g. in the morphology of bacterial cells and colonies, total cellular proteins, fatty acid methyl esters, reactions to bacteriophages, reactions to antisera (serological variations), and in the genome (DNA profiles).

Bacterial strains from 33 different geographical areas have been classified into three serovars (serological groups) and at least four genomic groups (ROTT *et al.*, 1994b; DAVIS *et al.*, 1994; DAVIS & ROTT, unpublished results). There is just one type of variation in some zones. However, two serovars and four different genomic groups were found in Mauritius. No correlations have yet been established between the different types of variation.

These results confirm that it is essential to halt transmission of the causal agent between geographical areas.

Serological variations should be taken into account when serological techniques (e.g. ELISA) are used to diagnose leaf scald disease. Efficient diagnosis requires sera that will react to different serological types of the bacterium.

The most certain way of investigating pathogenicity in *X. albilineans* would be to focus on its genomic variations, as indicated by the following observation in a study conducted in Florida: the increased incidence of leaf scald is directly associated with a genetic variant of the bacterium (DAVIS, 1992; DAVIS *et al.*, 1993). Studies are under way at the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD, France) and the University of Florida on the relations between genomic variability and pathogenicity in the bacterial organism. A positive correlation between these two *X. albilineans* traits would facilitate identification of highly virulent pathogenic strains, and enhance the efficiency of screening for improved varieties of sugarcane.

fully understood what triggers expression of symptoms after a latency period. The usual explanation is that different types of stress, (e.g. nutritional or climatic stress), prompt progress of the disease.

This latency phase is one of the chief obstacles to overcome for controlling leaf scald. Sugarcane plants can tolerate the presence of the causal agent for several weeks or even months without any sign of symptoms — sometimes there is expression, but it is too slight to be visible

(ROTT *et al.*, 1988; RICAUD & RYAN, 1989). The disease has thus spread worldwide via cuttings from healthy-looking plants.

The eclipse phase can occur at the same time as latency. It is characterized by white lines appearing and disappearing on the leaves during plant growth. These symptoms are no longer visible after senescence and death of the oldest leaves, and then there are no signs on newly-formed leaves. Hence, a plant can appear diseased or healthy, depending on when it is inspected.

## Geographical distribution

Leaf scald of sugarcane was first reported in 1911 in Australia by North (MARTIN & ROBINSON, 1961). However, it seems that the disease appeared in Fiji in 1908, or even much earlier.

This leaf disease induced substantial crop losses at the outset of the century in noble cane varieties (*S. officinarum*). It was partially controlled through the introduction of resistant hybrids containing *S. spontaneum* genes (RICAUD & RYAN, 1989). However, there were frequent outbreaks, for unknown reasons, in several countries. For instance, the 1964 epidemic in Mauritius seemed to be related to a loss of resistance in two widely-grown sugarcane varieties, and the likely appearance of a novel *X. albilineans* strain (RICAUD & PEROMBELON, 1964).

In the last 10 years, leaf scald outbreaks have again been reported in Guadeloupe, Florida, Dominican Republic, Mauritius and Taiwan. In Florida, it was associated with a new pathogenic strain (DAVIS, 1992). In Mauritius, it seems that the serious 1989 epidemic was caused by aerial transmission of the bacterium (AUTREY *et al.*, 1992b). There is a current increase in the number of regions affected by this disease. The latest reported new locations are Mexico (IRVINE *et al.*, 1993), Louisiana (GRISHAM *et al.*, 1994), Texas (ISAKEIT, personal communication, 1994) and Guatemala (OVALLE *et al.*, 1995). Leaf scald has now been detected in at least 61 different geographical locations (Figure 1).

## Economic impact

Leaf scald can totally destroy plantations of susceptible varieties within a few months or years. Spectacular drops in cane yields have been noted with infections of the acute form of the disease.

## Direct losses: cane yields and juice quality

This disease affects cane yields at harvest and the quality of extracted juice (HOY & GRISHAM, 1994). In Guadeloupe, COCHEREAU & JEAN-BART (1989) estimated crop losses of 13 t/ha of cane as determined by yield differences between millable healthy cane and diseased cane. On the same island, field sugarcane yield losses of 15-20% were noted for the susceptible variety B69379 (ROTT *et al.*, 1995).

In Mexico, the disease was detected for the first time in 1992, when it was responsible for destroying 800 ha of cv Mex64-1487. At the present time, cv Mex69-290, which is grown on 150 000 ha (25% of the sugarcane area), is relatively unaffected, despite the fact that preliminary

studies highlighted its susceptibility (scalded cane with side-shoot development). There could be a considerable financial impact if cv Mex69-290 is actually susceptible and the disease progresses in Mexico. A 1% yield loss would represent an economic loss of about 15 million new Mexican pesos, or about 24 million FF (October 1994 estimate, based on a mean field yield of 100 t/ha of cane and 100 pesos/t paid to farmers).

## Indirect losses: replanting and breeding costs

Leaf scald also has an indirect impact, e.g. cost of replanting destroyed plantations, propagation of healthy plants (micropropagation and heat treatment) and selection of resistant varieties. Moreover, some high-yielding varieties that are



Aspect of a diseased stalk: whiting of leaves that curl inward, giving a spindly appearance.

Photo P. Rott

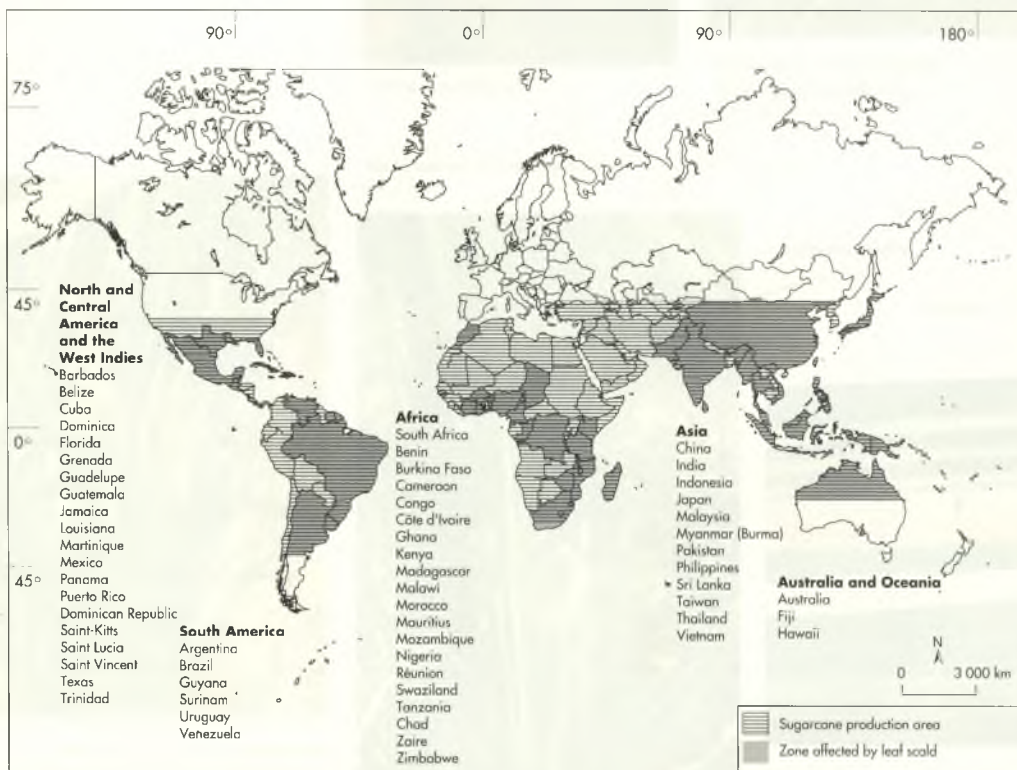


Figure 1. Current locations affected by sugarcane leaf scald.



# Leaf scald symptoms in sugarcane



General aspect of a sugarcane stool affected by leaf scald.  
Photo P. Rott

Brownish-red discoloration of vascular tissue colonized by *Xanthomonas albilineans*.  
Photo P. Rott



Bevelled stalk section.



Longitudinal section of the stalk.

White pencil line on the leaf blade.  
Photo P. Rott



Foliar symptoms of sugarcane leaf scald.  
Photo P. Rott



Diseased plant with side shoots also exhibiting foliar symptoms of leaf scald.  
Photo P. Rott



susceptible to the disease should not be grown, e.g. Q63 in Australia, B69379 in Guadeloupe and M 695 69 in Mauritius (EGAN, 1971; ROTT & FELDMANN, 1991; AUTREY *et al.*, 1992*b*). Recent outbreaks of leaf scald in Louisiana killed promising clones that were being bred, thus modifying varietal improvement strategies (HOY & GRISHAM, 1994).

## Control

Pathogen introductions can be avoided in regions where leaf scald is not yet present by only importing disease-free plant material. This is also true for already infected areas since there is always the risk of transmission of a new and more virulent bacterial strain. Strict measures should be taken to control distribution and exchange of plant material, especially cuttings.

For the purposes of efficient preventive control, sugarcane plants should be shipped by a quarantine station (BAUDIN, 1984; FRISON & PUTTER, 1993).

## Heat treatment of cuttings

No chemical control is used to treat leaf scald at the present time. Heat treatment of cuttings is an effective preventive control technique for destroying bacteria in infected tissues. It involves soaking the cuttings in water at room temperature for 48 h and then in hot water (50°C) for 3 h.

## Varietal screening

The most suitable and easy means of controlling leaf scald is by using healthy plant material and planting disease-resistant sugarcane cultivars.

It is also critical to pinpoint and eliminate susceptible varieties during the sugarcane selection process.

Varietal screening tests have been set up in several countries where the disease is prevalent. Resistance levels are generally assessed by checking for symptoms after artificial inoculation of stalks. Other methods which involve determining bacterial population densities in host plants are currently being investigated (ROTT *et al.*, 1994*a*, 1994*c*).

However, propagation of the disease cannot be completely controlled through the selection and use of resistant plants. Further prophylactic measures are also required: destruction of diseased material, disinfection of cutting tools by brushing them with or soaking them in bactericides, phytosanitary control prior to introducing plant material (quarantine).

## Sugarcane quarantine

Sugarcane productivity can be maintained through steady efforts to enhance the varietal status (i.e. all varieties cultivated in a zone at a given time) by introducing and assessing new varieties. Sugarcane crops are also especially vulnerable to diseases, because of various factors: propagation from cuttings facilitates spread of pathogens, monocropping over large areas is favourable to the development of epidemics, the pluriannual aspect of this crop (4-10 years on average) lengthens and complicates breeding.

Exchanges and transport of sugarcane cuttings is a serious risk that should be fully controlled. CIRAD thus set up a sugarcane quarantine unit in Montpellier (France) in the 1970s. This unit supplies disease-free cuttings, mainly to sugar-producing areas of western and central Africa, sugarcane breeding stations in the West Indies (Guadeloupe) and Réunion, and there are prospects for supplying other regions. Moreover, CIRAD, in addition to having

greenhouses set up to monitor sugarcane plants and propagate cuttings, has developed indexing techniques (serological tests such as ELISA and immunofluorescence) for reliable and precise diagnosis of the following diseases: mosaic, red leaf mottle, streak, leaf scald and ratoon stunting.

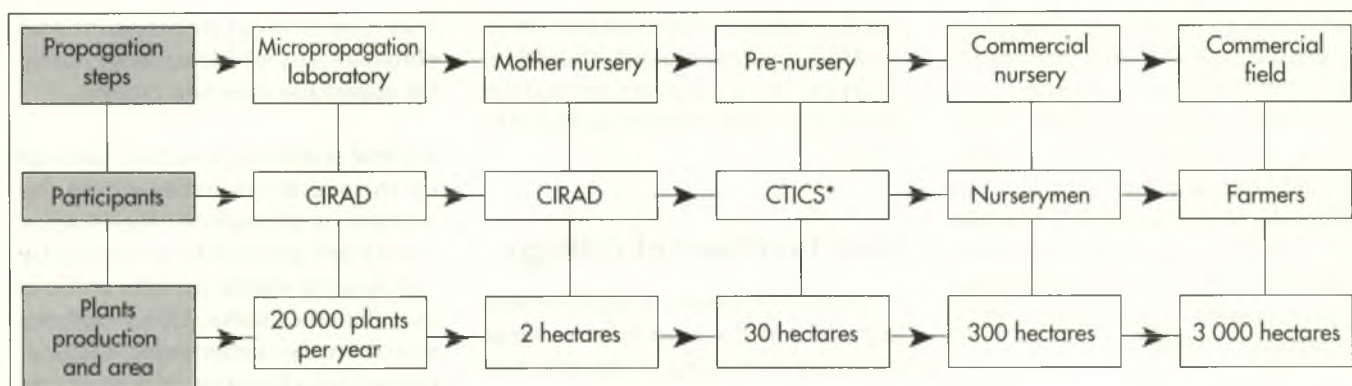
Clones distributed by this quarantine unit come from three sources: clones from early stages of selection from CIRAD research stations in Guadeloupe and the West Indies Central Sugarcane Breeding Station (WICSCBS) in Barbados and commercial varieties from various origins worldwide.

Varieties to be analysed are sent in directly by the source countries (about 10 buds/variety). The sugarcane cuttings are then left to germinate in a climate-controlled room at 30°C. Once they have grown a few centimetres, the young plantlets are replanted in pots on artificial medium, drip watered and placed in quarantine greenhouse n°1. The canes are sprayed with fungicides

and insecticides at planting and several times during their growth cycle. They are visually inspected regularly and tests are carried out to detect the presence of any causal agents. The sugarcane stalks are heat treated (cuttings immersed in water at 25°C for 2 days, and then at 50°C for 3 h) at the end of the growth cycle, after 9-10 months in the greenhouse.

Thereafter, canes are cultured again from cuttings in quarantine greenhouse n°2 to produce a new set of cuttings. The plant material is once more inspected, treated and tested. After 9-12 months growth, the cuttings undergo a short heat treatment (soaking in hot water for 1 h at 50°C) and are dipped into a fungicide. These cuttings can then be dispatched from the quarantine unit with a phytosanitary certificate issued by the French crop protection service.

For further information, contact the Head of the Sugarcane Quarantine Unit, CIRAD-CA, BP 5035, 34032 Montpellier Cedex 1, France. Tel. (33) 67 61 65 55; fax (33) 67 61 56 03.



\* CTICS: Centre technique interprofessionnel de la canne à sucre.

Figure 2. Propagation steps of sugarcane in Guadeloupe.

## Disease-free commercial fields

Nurseries are specifically set up to supply farmers with cuttings for their commercial fields (sugar production). They aim at providing their customers with perfectly healthy plant material, and therefore represent a crucial step in controlling plant diseases, particularly bacterial diseases, which are commonly transmitted through cuttings.

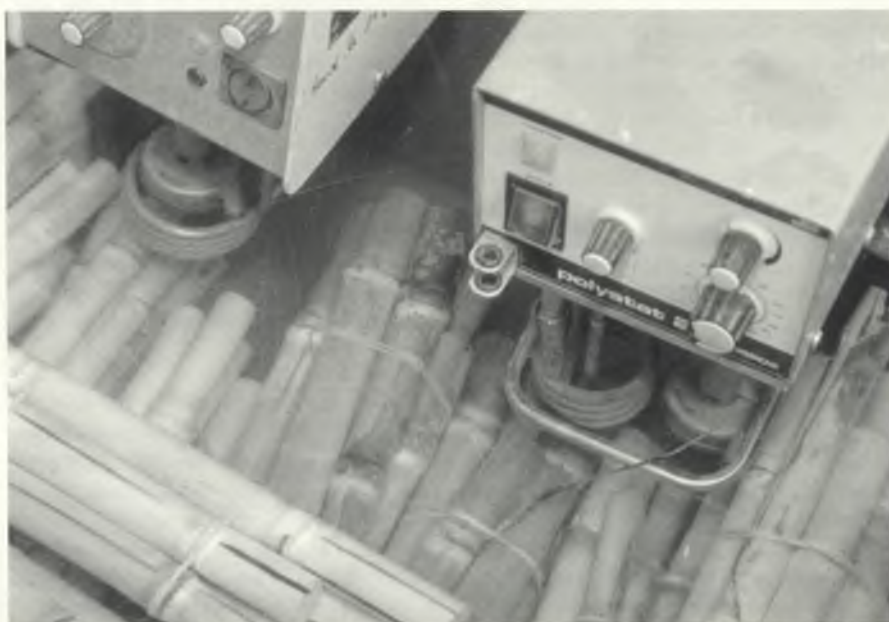
Cuttings planted in these nurseries usually come from mother nurseries. The latter should thus be under strict control, certifying that all planting material is healthy or sanitized, i.e. controlled plants obtained through micropropagation or from cuttings that have undergone the previously described long hot water treatment.

## An example: Guadeloupe

The goal of the new sugarcane propagation system in Guadeloupe is to sanitize plantations contaminated with various diseases, especially leaf scald (Figure 2).

The system includes a mother nursery, which provides cuttings for a second propagation nursery (pre-nursery), which in turn supplies the commercial nursery with cuttings.

This latter nursery produces cuttings for the sugarcane farmers. The first two nurseries should be remotely located with respect to the commercial nurseries. Disease-free micropropagated plants, produced in the CIRAD research station at Roujol (Guadeloupe), are planted in the mother nursery (FELDMANN & ROTT, 1991). This propagation system provides sugarcane farmers with cuttings of excellent genetic (no varietal blends, new improved varieties), physiological (young cuttings) and phytosanitary (disease-free) quality.



Heat treatment of cuttings.  
Photo T. Erwin



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Growth of side shoots  
with no apical dominance.

Photo P. Rott

## Abstract... Resumen... Résumé

### P. ROTT — Leaf scald of sugarcane.

Leaf scald of sugarcane is a bacterial disease caused by *Xanthomonas albilineans* (Ashby) Dowson. The economic consequences may be serious when susceptible varieties are affected in production areas. Symptomatology includes a chronic form and an acute form as well as latency and eclipse phases that make diagnosis difficult. The disease is currently found in at least 61 sugarcane production zones. It spreads particularly rapidly in cuttings. Preventive control methods are used i. e. selection of resistant plants, control of the exchange of plant material by the use of a quarantine station, nursery production of perfectly healthy cuttings and heat treatment of cuttings. Control of leaf scald of sugarcane is not possible without a strict system of multiplication and diffusion of plant material from the production of tissue culture plants for planting out in a "mother nursery" to the supply of healthy plants for setting out in commercial fields.

**Keywords:** leaf scald, sugarcane, *Xanthomonas albilineans*, quarantine, varietal selection, heat treatment, vegetative propagation, Guadeloupe, tropics.

### P. ROTT — La escaldadura de la hoja de caña de azúcar.

La escaldadura de la hoja (*leaf scald*) de caña de azúcar es una enfermedad bacteriana vascular provocada por *Xanthomonas albilineans* (Ashby) Dowson. Las consecuencias económicas pueden ser graves cuando resultan afectadas algunas variedades sensibles en las zonas de producción. La sintomatología incluye una forma crónica, una forma aguda y fases denominadas de latencia y eclipse que hacen el diagnóstico delicado. Actualmente, esta enfermedad está presente en por lo menos 61 zonas productoras de caña de azúcar y se propaga con gran rapidez puesto que es transmitida por los esquejes. Los métodos de lucha son preventivos: selección varietal de plantas resistentes, control de los intercambios de material vegetal mediante una estación de cuarentena, producción de esquejes perfectamente sanos a partir de viveros y técnicas de termoterapia de los esquejes. El control de la escaldadura de la hoja de caña de azúcar sólo es posible en un esquema riguroso de multiplicación y difusión del material vegetal, desde la producción de vitroplántulas para crear el vivero madre hasta el suministro de esquejes sanos para la plantación de campos comerciales.

**Palabras clave:** escaldadura de la hoja, caña de azúcar, *Xanthomonas albilineans*, cuarentena, selección varietal, termoterapia, multiplicación vegetativa, Guadalupe, zona tropical.

### P. ROTT — L'échaudure des feuilles de la canne à sucre.

L'échaudure des feuilles (*leaf scald*) de la canne à sucre est une maladie bactérienne vasculaire provoquée par *Xanthomonas albilineans* (Ashby) Dowson. Les conséquences économiques peuvent être graves lorsque des variétés sensibles sont atteintes dans les zones de production. La symptomatologie comporte une forme chronique, une forme aiguë ainsi que des phases dites de latence et d'éclipse qui rendent le diagnostic délicat. Actuellement, cette maladie est présente dans au moins 61 zones de production de la canne à sucre. Elle se propage d'autant plus rapidement qu'elle est transmise par les boutures. Les méthodes de lutte sont préventives : sélection variétale de plantes résistantes ; contrôle des échanges de matériel végétal par une station de quarantaine ; production de boutures parfaitement saines à partir des pépinières ; techniques de thermothérapie des boutures. La maîtrise de l'échaudure des feuilles de canne à sucre ne peut être possible sans un schéma de multiplication et de diffusion du matériel végétal rigoureux, depuis la production de vitroplants pour la mise en place de la pépinière mère à la fourniture de boutures saines pour la plantation des champs commerciaux.

**Mots-clés :** échaudure des feuilles, canne à sucre, *Xanthomonas albilineans*, quarantaine, sélection variétale, thermothérapie, multiplication végétative, Guadeloupe, zone tropicale.



Whitening on a leaf blade due to albidine, a toxin produced by *Xanthomonas albilineans*.

Photo P. Rott